

Recycling Technical Assistance Project # 540

City of Philadelphia, Philadelphia County

Recyclable Composition Analysis

*Sponsored by the Pennsylvania Department of Environmental Protection
through the Pennsylvania State Association of Township Supervisors*

FINAL REPORT

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RECYCLING TECHNICAL ASSISTANCE PROJECT #540

CITY OF PHILADELPHIA, PHILADELPHIA COUNTY

RECYCLABLE COMPOSITION ANALYSIS

1. STATEMENT OF THE PROBLEM

Curbside recycling service in the City of Philadelphia is provided weekly to approximately 525,000 households, with collections performed by City crews and vehicles. A wide array of materials are accepted including newspaper, cardboard, mixed paper, plastics #1 through #7s, aluminum and steel food and beverage cans, glass bottles and jars, and aseptic packaging. The residential program is supported by extensive outreach, as well as the Philadelphia Recycling Rewards Program (Recyclebank).

The City contracts with a private Materials Recovery Facility (MRF) to provide recyclables processing services, and receives a net revenue per-ton payment based on quarterly changes to commodity market prices. The City's net revenues are calculated based on published market prices for fiber and metal, glass and plastic food and beverage containers multiplied by their proportionate share of the overall recyclables stream. The composition estimate used in the formula is based on a 2010 composition study.

A number of factors have necessitated an update of the formula used to determine the value of City recyclables:

- ◆ The City has made numerous changes to its residential recycling program in recent years, including increased collection frequency, outreach and incentives, and through the addition of new materials, including aseptic cartons, and #3-7 mixed rigid plastics.
- ◆ Stricter bale quality standards being imposed on MRF operators by export markets underscore the need for more effective public education. Outreach during the past few years has primarily focused on increasing recycling yields, with less focus on materials quality. The City wishes to sample rejects and MRF residue to help determine where quality control messaging should be focused.
- ◆ Effective January, 2014, the market index utilized to calculate fiber market changes will cease publishing pricing for the ONP #6 grade, to which the newspaper fraction of the City's recyclables stream is tied. In order to determine a replacement fiber grade or market index, a better understanding of the composition of the newspaper fraction is required.
- ◆ Finally, in FY 2014 the City will be issuing a Request for Proposals (RFP) to secure a new recyclables processor, with new services set to begin on July 1, 2014. In order to secure favorable contract terms, an updated recyclables composition analysis is necessary prior to letting of the MRF services RFP.

MSW Consultants designed a sampling and sorting protocol, and subsequently performed an audit, for the City of Philadelphia to update the composition of its residentially collected recyclables.

2. SUMMARY OF WORK COMPLETED

The specific Recyclable Composition Analysis tasks performed for the City of Philadelphia are summarized below.

- ◆ **Task 1 - Sampling Plan Development:** Published protocols specify a representative sampling process for accurately determining the composition of curbside recyclables. In this task, a sampling and sorting protocol was developed based on a review of City collection and routing data. A total of 60 samples were targeted for the study. The following elements of the Sampling Plan are included in Appendix A:
 - ◆ **Exhibit A-1:** Monthly reports summarizing the tonnage of curbside recyclables collected by collection district. These data are from the period July, 2012 through June, 2013.
 - ◆ **Exhibit A-2:** The random allocation of samples across districts and the randomly selected routes to be targeted.
 - ◆ **Exhibit A-3:** Material definitions used in the study.
- ◆ **Task 2 – Field Data Collection:** Sampling and sorting were performed during the week of September 30, 2013 through October 4, 2013 at the Waste Management (WM) MRF that currently processes the City’s recyclables. Targeted routes were identified at the inbound scalehouse as they arrived. The weigh master radioed the WM sort foreman who directed the targeted collection vehicle to the proper tip floor location. Loads were mixed and coned, and a sample was taken using a rubber tire loader with a small 2 cubic yard bucket without a rubber wear strip on the cutting edge of the bucket. The sample was dumped in a one cubic yard wheeled dump-cart. These carts were wheeled from the tip floor to the sorting area located in an adjacent building.

Sorting was performed by WM staff but supervised by MSW Consultants. The wheeled carts were labeled and staged in the order in which they were collected. Each cart was individually dumped on the sorting table for manual sorting into the 29 material categories listed in Appendix A, Exhibit A-3.

Each material was manually sorted and placed in a labeled container. After the entire sample was sorted each container was weighed on a small digital scale and the weight recorded on a field data collection form.
- ◆ **Task 3 Data Analysis:** The weight data from the sorted material was entered into a database for detailed statistical analysis. The data were checked for accuracy in two ways: (1) randomly checking the data entry of 10% of the samples, and (2) running logical queries to identify unlikely and/or illogical data points (for example, if any materials had a negative weight or if any materials weighed more than an expected maximum weight). The mean composition and 90 percent confidence intervals were generated for each material category and material group.
- ◆ **Task 4 Report:** This report contains a brief summary of the study design and presentation of the results.

3. POSSIBLE SOLUTIONS AND RECOMMENDATION

Because of the research-related nature of this Technical Assistance Project, this section presents the results of the composition analysis of the City of Philadelphia's curbside recycling stream. Detailed tabular results are contained in Appendix B:

- ◆ **Exhibit B-1** contains the results of the statistical analysis, including the mean composition and 90 percent confidence intervals. These results include all samples.

It should be noted that 13 of the 60 samples obtained for this project were either heavier than 200 lbs or lighter than 100 lbs. In order to determine if these heavy or light samples introduced any bias into the results, the mean composition was calculated excluding these samples. The mean composition percentages shown in Exhibit B-1 did not change appreciably when filtering out either heavy samples, light samples, or both heavy and light samples. Based on this exercise, it can be concluded that the sampling process, which was based on volume of material rather than on the weight, did not impact the veracity of the analysis.

- ◆ **Exhibit B-2** re-states the results to better inform the establishment of the formula used to determine the value of City recyclables. This Exhibit reflects the composition of recyclables in four ways:

- ◆ The incidence of each material in the sort as a percentage of total incoming material (both targeted recyclables and contaminants),
- ◆ The incidence of each targeted recyclable as a percentage of all targeted recyclables,
- ◆ The incidence of each targeted Paper material as a percentage of all Paper, and
- ◆ The incidence of each targeted Bottle/Can material as a percentage of all Bottles/Cans.

These results have been provided to the City in Excel format for use in the upcoming procurement process.

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APPENDIX A

SAMPLING PLAN DETAILS

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Exhibit A-1: FY2013 Recycle Tonnage

Month	Collection District													Citywide
	1A	1B	2B	2D	3C	3F	4G	4M	5F	5L	6A	6B	6L	
Jul-12	683.4	674.2	865.2	702.2	604.9	629.0	739.6	870.7	816.4	667.8	808.4	920.8	904.4	9,887.0
Aug-12	703.8	727.2	912.1	718.9	638.3	650.8	772.6	852.4	872.3	667.4	835.9	978.2	957.8	10,287.5
Sep-12	636.0	697.6	859.7	694.8	612.7	606.4	700.4	841.2	801.6	620.0	776.5	943.4	903.7	9,693.9
Oct-12	633.6	635.4	846.8	691.1	580.7	568.6	708.6	809.8	774.7	577.2	783.0	938.0	821.5	9,368.9
Nov-12	747.1	749.6	1,013.3	802.8	662.1	686.0	798.9	964.9	901.9	707.9	940.3	1,105.7	1,058.9	11,139.5
Dec-12	677.0	673.7	899.2	753.3	604.1	635.8	705.9	895.4	852.1	648.0	875.2	1,062.6	992.3	10,274.5
Jan-13	667.0	743.2	969.8	801.9	643.5	639.4	763.4	923.5	897.4	645.7	815.8	1,036.8	986.5	10,533.9
Feb-13	575.9	595.6	757.8	630.5	542.9	559.2	614.3	745.1	750.8	522.4	696.7	832.3	803.0	8,626.3
Mar-13	619.9	590.6	799.7	675.0	567.9	630.2	669.5	802.9	817.6	557.3	756.4	882.5	874.4	9,243.8
Apr-13	672.2	640.0	883.8	721.3	638.6	645.1	744.9	806.2	862.9	642.8	808.7	1,001.6	925.0	9,993.1
May-13	706.4	712.9	913.6	766.6	654.6	670.2	773.4	894.3	902.8	699.1	882.0	1,008.9	1,029.1	10,613.8
Jun-13	704.8	703.3	869.8	735.0	641.5	714.1	756.6	902.2	891.2	666.7	910.0	981.3	1,025.9	10,502.4
FY13 Total	8,027	8,144	10,591	8,693	7,392	7,635	8,748	10,309	10,142	7,622	9,889	11,692	11,283	120,165
% of Total	6.7%	6.8%	8.8%	7.2%	6.2%	6.4%	7.3%	8.6%	8.4%	6.3%	8.2%	9.7%	9.4%	100.0%

Exhibit A-2 Determination of Routes to be Sampled

Stratified Random Allocation of Samples

	1A	1B	2B	2D	3C	3F	4G	4M	5F	5L	6A	6B	6L	Total
Samples Required	4	4	5	4	4	4	4	5	5	4	5	6	6	60
Monday	1	1	1	1	1	1	1	1	1		1	1	1	12
Tuesday		1	1	1	1		1	1	1	1	1	2	1	12
Wednesday	1		1	1	1	1		1	1	1	1	1	2	12
Thursday	1	1	1		1	1	1	1	1	1	1	1	1	12
Friday	1	1	1	1		1	1	1	1	1	1	1	1	12
Total	4	4	5	4	4	4	4	5	5	4	5	6	6	60

Random Selection of Routes to be Sampled

	1A	1B	2B	2D	3C	3F	4G	4M	5F	5L	6A	6B	6L
Monday	202	204	203	201	202	204	204	203	201		206	205	207
Tuesday		305	304	303	301		303	303	302	304	306	306	306
Tuesday												302	
Wednesday	404		405	402	403	403		403	402	401	405	405	402
Wednesday													405
Thursday	505	503	506		502	503	505	505	503	503	504	506	502
Friday	601	602	608	606		607	601	605	604	602	602	605	606

Exhibit A-3 Material Definitions

Class	Cat #	Material Categories	Material Definitions
PAPER	1	OCC/Kraft	Paperboard containers consisting of Kraft (brown) linerboard with corrugated (fluted medium) fillings. Includes yellow and waxed corrugated boxes and Kraft paper such as bags or wrapping paper. Does not include non-corrugated paperboard products such as cereal, shoe, or gift boxes.
	2	Newspaper	Consists of all paper products printed on daily or weekly newspapers, advertising, catalogs, and other similar items. Publications can be one color (e.g., black and white) or multicolor.
	3	High Grade Paper	High grade ledger paper, such as typing and copy paper. Computer paper includes outputs from printers that may have green bars.
	4	Magazines/Glossy	Publications which are printed on glossy paper. This does not include magazines, catalogs, etc., which do not consist of glossy paper throughout (e.g., comic books).
	5	Mixed (Other Recyclable)	All other recyclable paper not covered such as non-corrugated paperboard boxes, direct mail, and books.
	6	Polycoated / Aseptic Containers	Aseptic juice boxes and gable top cartons.
	7	Compostable Paper	Tissues and paper including OCC that are soiled with food, such as paper plates, un-coated paper cups, pizza boxes, popcorn bags and paper towels.
	8	Hot & Cold Beverage Cups	Paper cups that are coated with wax or polycoated with plastic film to protect from liquids. Does not include expanded polystyrene cups.
	9	Other Paper (Non-Recyclables)	All paper products not covered by the above categories, including soiled and unsoiled tissues, paper towels, napkins, file folders, carbonless paper forms, and tissue (tracing) paper.
PLASTIC	10	#1 PET Bottles/Jars	Clear or colored blow molded plastic bottles (i.e., with a narrow neck) labeled #1 PET.
	11	#2 HDPE Bottles/Jars Natural	Natural blow molded plastic bottles (i.e., with a narrow neck) labeled #2 HDPE.
	12	#2 HDPE Bottles/Jars Colored	Pigmented blow molded plastic bottles (i.e., with a narrow neck) labeled #2 HDPE.
	13	#3 - 7 Bottles/Jars	Blow molded bottles labeled #3, #4, #5 or #7.
	14	Injection Molded Tubs and Cups	Tubs and cups that are injection molded. All injected molded tubs will have a small dot left from the manufacturing process, not a seam. Examples include margarine, cottage cheese, yogurt tubs, and buckets (including 1,2, and 5-gallon buckets).
	15	Clamshell Food Containers	A one-piece container usually constructed of #1, #5, or #6 plastic resin consisting of two halves joined by a hinge area which allows the structure to come together to close. Clamshells are often made of a shaped plastic material, in a way that is similar to a blister pack. The name of the clamshell is taken from the shell of a clam, which it resembles both in form and function.
	16	Expanded Polystyrene	Expanded foam packaging, trays or containers labeled #6 PS. Includes foam polystyrene cups and food service containers (i.e., "clamshells") as well as clean service containers and packing "peanuts".
	17	Films/Bags	Linear, translucent to opaque films/bags, such as grocery bags, dry film, trash and garbage bags.

Exhibit A-3 Material Definitions

Class	Cat #	Material Categories	Material Definitions
PLASTIC	18	Other Rigid Plastic	Rigid plastic not elsewhere classified. Includes plastic tubs, cups, trays, straws, and cutlery. Unmarked plastics such as materials made of multi-composite materials that may contain more than one type of plastic and/or metal, and all other plastics not otherwise described including items such as toys.
	19	Glass Bottles and Jars	Clear, green, and brown glass food and beverage containers.
GLASS	20	Other Glass	Includes a variety of miscellaneous glass products such as mirrors, leaded crystal, eyeglasses, and blown glass such as light bulbs, auto glass, windows, TV tubes, heat resistant cookware (Pyrex), pottery, and drinking glasses.
	21	Ferrous Cans	Fabricated, magnetizable metal containers such as steel or bimetal designed to hold food or beverage products such as soups, vegetables, pet food and juices. Includes two piece containers with aluminum tops.
METAL	22	Household Metals	House ware products that are predominantly (>50%) constructed of aluminum or steel such as spoons, pots, pans, trays, etc.
	23	Other Ferrous Metals	Ferrous and alloyed ferrous scrap materials originated from residential commercial, or institutional sources which are attracted to a magnet. This category includes wire coat hangers, aerosol cans, and auto parts.
	24	Aluminum Cans	Aluminum containers used for holding beverages, food, empty aerosol cans, etc.
	25	Aluminum Foil & pans	All aluminum foil, and foil trays/tubs. Trays and tubs typically have a corrugated edge on the top and are used for take out.
	26	Other Aluminum	All other scrap aluminum such as siding, sheet, wire, window and door frames, etc.
	27	Other Non-Ferrous	Non-magnetic metals such as brass, bronze, silver, lead copper, and zinc. Stainless steel house wares are also part of this category.
	28	Appliances	Stoves, refrigerators, dishwashers and all other large and small household appliances including fragments.
+	29	Other Non-Program Waste	All other organic, inorganic electronic waste that are not described above.

APPENDIX B

RESULTS

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Exhibit B-1 Statistical Analysis of the Composition of Curbside Recyclables

Class	Subclass	Average	90% Conf Interval	
		Percent	Lower	Upper
Paper		40.9%	38.0%	43.9%
1	OCC/Kraft	12.1%	10.4%	13.7%
2	Newspaper	10.4%	8.6%	12.1%
3	High Grade Paper	0.5%	0.0%	0.9%
4	Magazines/Glossy	3.1%	2.3%	4.0%
5	Mixed (Other Recyclable)	13.8%	12.5%	15.1%
6	Polycoated / Aseptic Containers	0.4%	0.4%	0.5%
7	Compostable Paper	0.5%	0.4%	0.6%
8	Hot & Cold Beverage Cups	0.1%	0.1%	0.1%
9	Other Paper (Non-Recyclables)	0.1%	0.0%	0.1%
Plastic		12.0%	11.0%	13.1%
10	#1 PET Bottles/Jars	4.3%	3.9%	4.7%
11	#2 HDPE Bottles/Jars	1.2%	1.0%	1.3%
12	#2 HDPE Bottles/Jars Colored	1.2%	1.0%	1.3%
13	#3 - 7 Bottles/Jars	1.8%	1.6%	2.0%
14	Injection Molded Tubs and Cups	0.0%	0.0%	0.0%
15	Clamshell Food Containers	0.1%	0.1%	0.1%
16	Expanded Polystyrene	0.2%	0.2%	0.3%
17	Films/Bags	1.7%	1.5%	1.9%
18	Other Rigid Plastic	1.6%	1.0%	2.2%
Glass		32.7%	29.7%	35.8%
19	Glass Bottles and Jars	31.6%	28.6%	34.6%
20	Other Glass	1.2%	0.5%	1.8%
Metal		5.6%	4.9%	6.3%
21	Ferrous Cans	2.8%	2.5%	3.1%
22	Household Metals	0.4%	0.3%	0.6%
23	Other Ferrous Metals	0.6%	0.2%	1.0%
24	Aluminum Cans	1.2%	1.1%	1.4%
25	Aluminum Foil & pans	0.1%	0.0%	0.2%
26	Other Aluminum	0.0%	0.0%	0.0%
27	Other Non-Ferrous	0.0%	0.0%	0.1%
28	Appliances	0.4%	0.1%	0.7%
Other Waste		8.7%	6.9%	10.4%
29	Other Non-Program Waste	8.7%	6.9%	10.4%
Total		100.0%		

Exhibit B-2 Relative Composition of Curbside Recyclables

Program	Targeted	No.	Subclass	Percent of Incoming	Percent of Recyclables	Percent of Paper	Percent of Bottles/Cans
Recyclable	Paper	1	OCC/Kraft	12.1%	14.0%	30.0%	N/A
		2	Newspaper	10.4%	12.0%	25.7%	
		3	High Grade Paper	0.5%	0.6%	1.2%	
		4	Magazines/Glossy	3.1%	3.6%	7.7%	
		5	Mixed (Other Recyclable)	13.8%	16.0%	34.3%	
		6	Polycoated / Aseptic Containers	0.4%	0.5%	1.0%	
			Subtotal Paper	40.2%	46.7%	100.0%	
	Bottles/Cans	10	#1 PET Bottles/Jars	4.3%	5.0%	N/A	9.3%
		11	#2 HDPE Bottles/Jars	1.2%	1.4%		2.5%
		12	#2 HDPE Bottles/Jars Colored	1.2%	1.4%		2.6%
		13	#3 - 7 Bottles/Jars	1.8%	2.1%		3.9%
		14	Injection Molded Tubs and Cups	0.0%	0.0%		0.0%
		15	Clamshell Food Containers	0.1%	0.1%		0.2%
		16	Other Rigid Plastic	1.6%	1.9%		3.5%
		19	Glass Bottles and Jars	31.6%	36.7%		68.8%
		21	Ferrous Cans	2.8%	3.3%		6.1%
		24	Aluminum Cans	1.2%	1.4%		2.7%
		25	Aluminum Foil & pans	0.1%	0.1%		0.2%
			Subtotal Bottle & Can	45.9%	53.3%		100.0%
			Subtotal Recyclable	86.2%	100.0%		
Non-program/ Non-recyclable		7	Compostable Paper	0.5%	N/A	N/A	N/A
		8	Hot & Cold Beverage Cups	0.1%			
		9	Other Paper (Non-Recyclable)	0.1%			
		16	Expanded Polystyrene	0.2%			
		17	Films/Bags	1.7%			
		20	Other Glass	1.2%			
		22	Household Metals	0.4%			
		23	Other Ferrous Metals	0.6%			
		26	Other Aluminum	0.0%			
		27	Other Non-Ferrous	0.0%			
		28	Appliances	0.4%			
		29	Other Non-Program Waste	8.7%			
		Subtotal - Non-program/Non-recyclable	13.8%				
		Total	100.0%				